Convection Lab Demonstration

Name: _____ Date: _____

Group: _____ Group Role: _____

OVERVIEW

The students will describe and discuss a convection current. They will set up an experiment that illustrates convection currents and observe the movement of water over a heat source by putting drops of food coloring in an ocean pan.

CONCEPTS

- The fluid nature of water allows it to transport heat globally.
- The transmission of heat via the vertical flow of a liquid (or gas) in a liquid (or gaseous) medium is called convection.
- Convection is an extremely important mechanism in the oceans and the atmosphere.

MATERIALS

- 9-inch x 13-inch pan
- 3 cups
- Tap water
- Hot water
- Ice or chemical cold pack
- Food coloring
- Droppers
- Paper and pencil for logging observations

PROCEDURE

Engagement

Heat transfer is the process by which heat is exchanged between objects or parts of objects. Heat is generally transferred by convection, radiation, or conduction. For example, heat is transferred by conduction through the brick wall of a house and Earth receives heat from the Sun by radiation. In this activity, you will explore convection, heat exchange through movement of water, and currents that are caused as a result of heat flow.

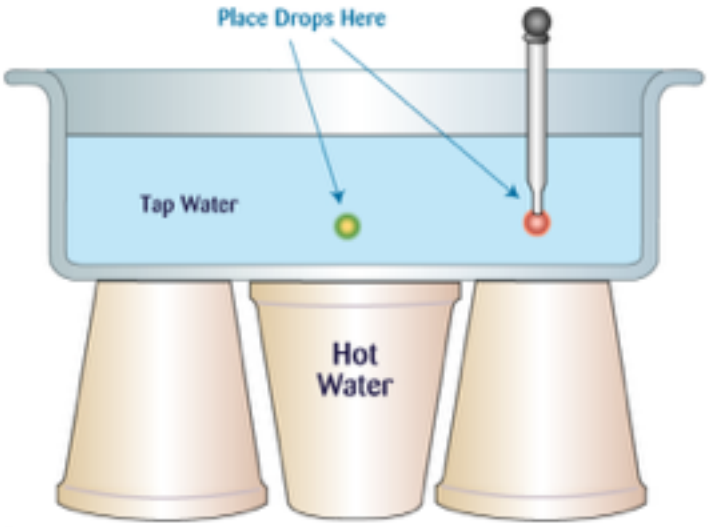

Figure 1. **Diagram showing the lab setup.**

Activity

1. Form a hypothesis about the way water will move in the pan based on figure 1.

2. Fill the pan 2/3 full with water. Turn two of the cups upside down (to use as a bridge) and set the pan of water on top of the two cups. Fill the third cup with hot water and place it under the center of the pan of water. Leave the pan for several minutes until the water has stopped moving. Put one drop of food coloring on the bottom of the pan in the center (directly over the heat source), and put one drop on the bottom halfway to the edge.

3. Observe what happens to the drops in your pan. Draw a diagram of what you observed.

Which way does the water move over the heat source?

What happens to the water when it reaches the surface?

What happens to the water when it reaches the edge?

Which way does the water move along the bottom of the pan?

4. Take the temperature of the water directly over the heat source and off to the side of the pan. Is there a difference in temperature?

How does this affect the drops of food coloring?

Summarize the results again, but this time in the context of the temperature changes.

5. Set up the experiment again. This time put hot water on the edges instead of the center of the pan. What happens if you use ice and make the water colder?

How does cold water affect the currents?

Explanation

The kind of movement observed takes place whenever liquids or gases are heated unevenly. The heat source under the center of the pan heats the water directly above it. This hot water rises to the surface, and spreads out toward the edges of the pan. As it moves farther from the heat source, the water cools and sinks back toward the bottom of the pan. As the cooler water moves toward the heat source, it becomes warmer and rises to the surface again. The motion of water in this pan is called a convection current [Fig. 2]. Oceans lose heat off Greenland and in the Weddell Sea. As they lose heat, the surface waters become more dense, and they may become so dense during winter that the water sinks to the bottom. This convection sets up vertical circulation in the ocean which also drives horizontal circulation, similar to that set up in the lab activity. For Earth, the net result is a transfer of heat from the equatorial regions to the polar regions. This mechanism, known as the global conveyor belt, is very important to regulating climate on Earth. Convection is also an extremely important mechanism in the atmosphere, constantly affecting weather and climate through the redistribution of energy. One of the most common examples of atmospheric convection occurs when the Sun heats Earth's surface, which in turn heats the atmosphere above it. As the lower atmosphere heats up, it moves heat upwards by convection. This process can produce winds on a local or even global scale. In the tropics, hot moist air rises over the ocean and drives vigorous atmospheric circulation.

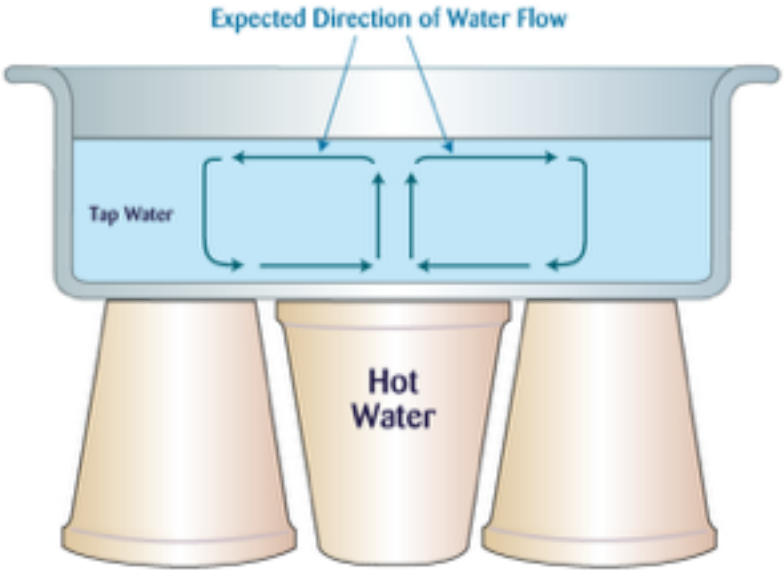

Figure 2. **Direction of water flow during the activity.**